# Isolated TR:
# when and how should we intervene?

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# Tricuspid regurgitation is a public health crisis

Maurice Enriquez-Sarano *, David Messika-Zeitoun, Yan Topilsky, Christophe Tribouilloy, Giovanni Benfari, Hector Michelena

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*Cardiovascular Department, University of Tel-Aviv, Israel*
*Cardiovascular Department, University of Amiens, France*

- ***Isolated*** tricuspid regurgitation =
  - TR without left sided valve disease,
  - without LV dysfunction
  - without pulmonary hypertension

Progress in Cardiovascular Diseases 62 (2019) 447–451

# TR unrecognized and untreated disease ?

- US prevalence of 1.6 million patients with prevalent moderate severe TR vs. the 8 to 10,000 tricuspid surgeries performed yearly. Considering the incident cases estimated in the nation no more than 4 to 5% of incident cases are ever operated.

- In the small subset of flail tricuspid leaflets, around 50% of cases underwent tricuspid surgery.

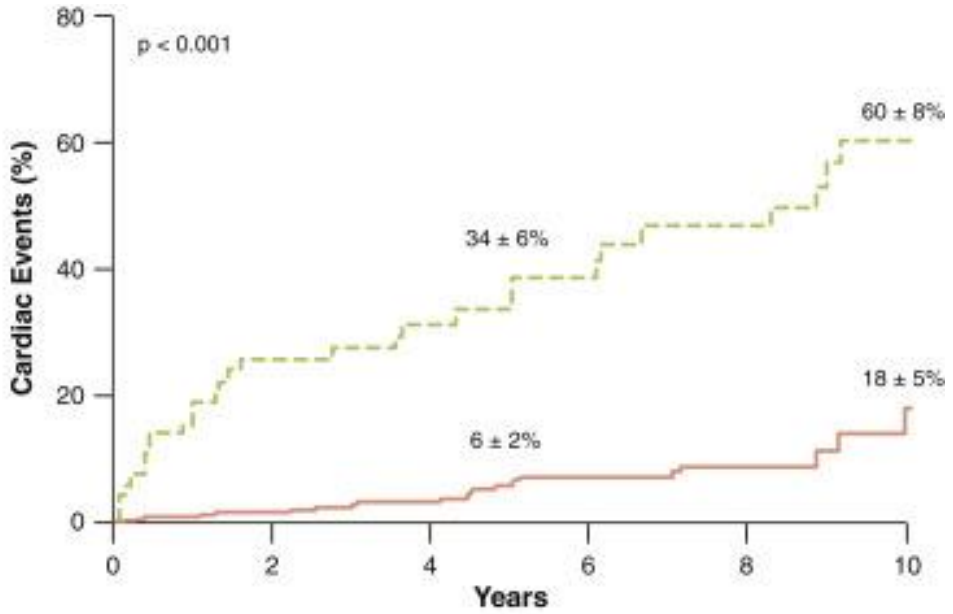
*Messika-Zeitoun D, J Thorac Cardiovasc Surg 2004;128: 296-302*.

- In the context of isolated TR, despite the absence of LV dysfunction, left-sided valve disease or PH, only 8% ever get tricuspid surgery performed.[28]

*Topilsky Y, J Am Coll Cardiol Img 2014;7:1185-1194*..

# Clinical Outcome of Isolated Tricuspid Regurgitation

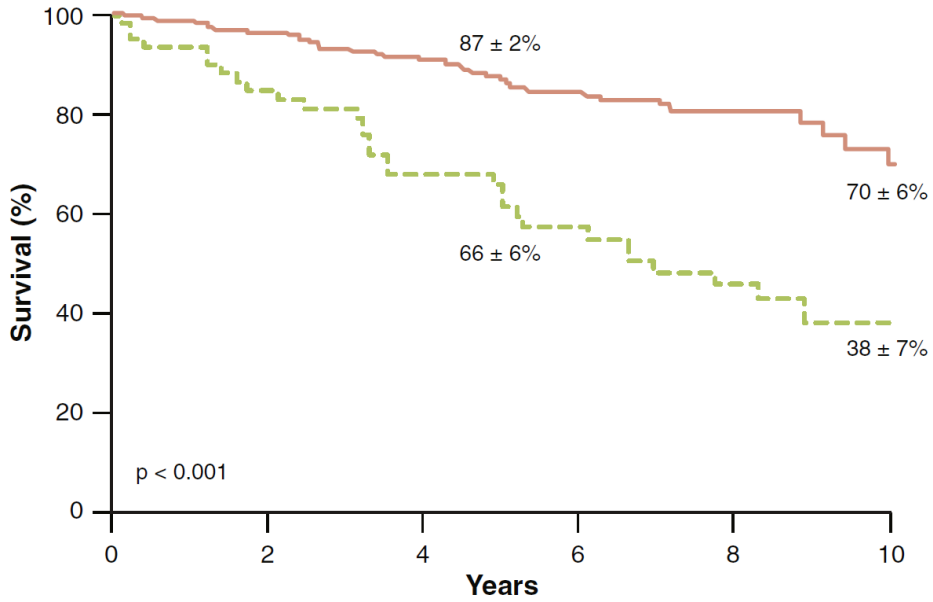
Yan Topilsky, MD,* Vuyisile T. Nkomo, MD,† Ori Vatury, MD,† Hector I. Michelena, MD,† Thierry Letourneau, MD,† Rakesh M. Suri, MD, DPHIL,‡ Sorin Pislaru, MD,† Soon Park, MD,‡ Douglas W. Mahoney, MSc,§ Simon Biner, MD,* Maurice Enriquez-Sarano, MD†




**Number at Risk**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total** | 353 | 294 | 242 | 183 | 65 | 29 |
| **ERO <40** | 285 | 252 | 209 | 160 | 46 | 23 |
| **ERO ≥40** | 68 | 42 | 33 | 23 | 19 | 6 |

ERO ≥40 mm² — ERO <40 mm²




**Number at Risk**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total** | 353 | 308 | 252 | 194 | 70 | 31 |
| **ERO <40** | 285 | 253 | 210 | 163 | 46 | 23 |
| **ERO ≥40** | 68 | 55 | 42 | 31 | 24 | 8 |

ERO ≥40 mm² — ERO <40 mm²

J Am Coll Cardiol Img 2014;7:1185-94

# Outcomes of isolated tricuspid valve replacement: a systematic review and meta-analysis of 5,316 patients from 35 studies

**Andrea Scotti**[1,2], MD; Matteo Sturla[1], MD; Juan F. Granada[1,2], MD; Susheel K. Kodali[3], MD; Augustin Coisne[1,2], MD, PhD; Antonio Mangieri[4], MD; Cosmo Godino[5], MD; Edwin Ho[1], MD; Ythan Goldberg[1], MD; Mei Chau[1], MD; Ulrich P. Jorde[1], MD; Mario J. Garcia[1], MD; Francesco Maisano[5], MD; Vinayak N. Bapat[6], MD; Gorav Ailawadi[7], MD, MBA; Azeem Latib[1]*, MD

| Outcome | Proportion/incidence rate % (95% CI) | $I^2$ % ($X^2$ *p*-value) | N. of studies |
|---|---|---|---|
| **Early outcomes** | | | |
| Bleeding | 12 (8-17) | 83 (<0.01) | 17 |
| Acute kidney injury | 15 (9-24) | 89 (<0.01) | 11 |
| Renal replacement therapy | 7 (3-15) | 63 (0.01) | 7 |
| Pacemaker implantation | 10 (6-16) | 75 (<0.01) | 13 |
| Respiratory complication | 15 (12-20) | 0 (0.56) | 7 |
| Stroke | 2 (1-4) | 74 (<0.01) | 9 |
| Wound infection | 3 (2-6) | 81 (<0.01) | 10 |

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| Outcome | Proportion/incidence rate % (95% CI) | $I^2$ % ($X^2$ *p*-value) | N. of studies |
|---|---|---|---|
| **Late outcomes** | | | |
| Late mortality* | 6 (4-9) | 96 (<0.01) | 23 |
| Reintervention* | 2 (1-3) | 64 (<0.01) | 15 |
| Structural valve deterioration* | 3 (1-6) | 82 (<0.01) | 9 |
| Valve thrombosis* | 1 (0-2) | 49 (0.07) | 8 |
| Recurrence of TR ≥2* | 5 (2-13) | 85 (<0.01) | 4 |
| **Bioprostheses** | | | |
| Late mortality* | 6 (2-13) | 97 (<0.01) | 8 |
| Reintervention* | 1 (1-3) | 77 (<0.01) | 5 |
| Structural valve deterioration* | 3 (1-9) | 91 (<0.01) | 4 |
| Valve thrombosis* | 0 (0-1) | 68 (0.04) | 3 |
| Recurrence of TR ≥2* | 8 (5-13) | 33 (0.22) | 3 |

*per 100 person-years. CI: confidence interval; TR: tricuspid regurgitation

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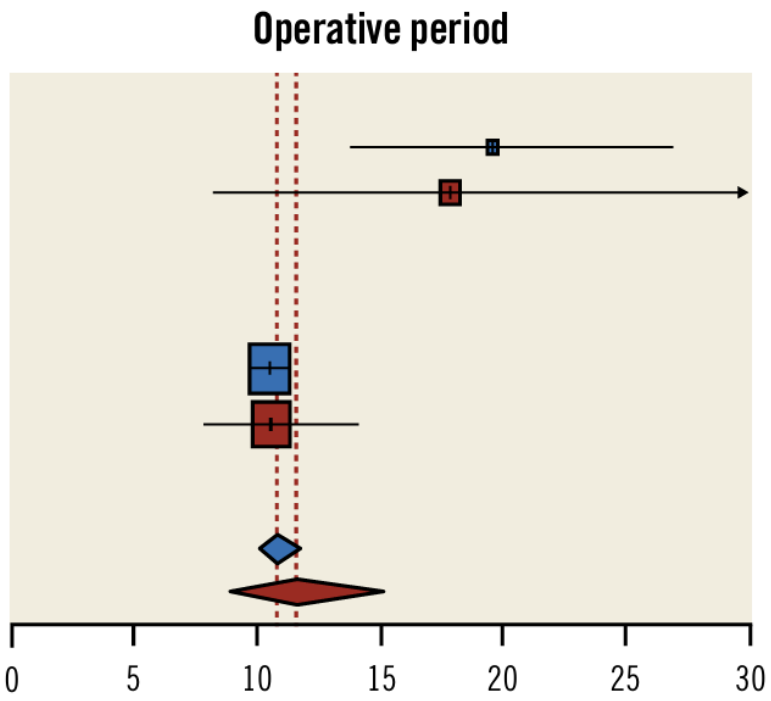
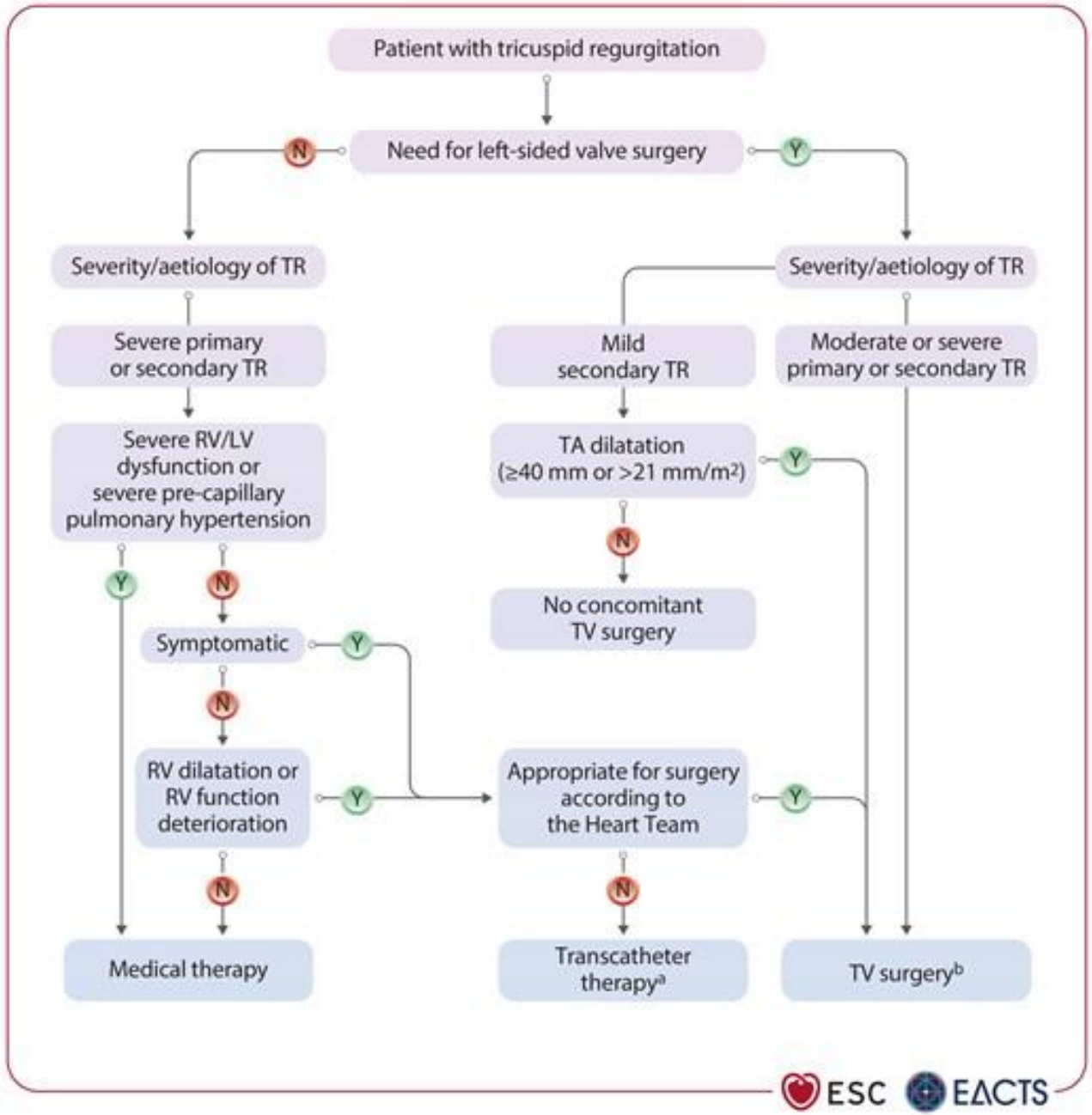
| Study | Events [95% CI] | Weight (random) | Weight (common) |
|---|---|---|---|
| **Before 1995** | | | |
| Common effect model | 19.5 [13.8-26.9] | – | 4.8% |
| Random effects model | 17.8 [8.2-34.5] | 18.9% | – |
| $I^2$=60%, $\tau^2$=0.5577, $\chi^2_6$=15.02 ($p$=0.02) | | | |
| **After 1995** | | | |
| Common effect model | 10.5 [9.6-11.4] | – | 95.2% |
| Random effects model | 10.5 [7.8-14.1] | 81.1% | – |
| $I^2$=68%, $\tau^2$=0.4424, $\chi^2_{25}$=77.68 ($p$<0.001) | | | |
| Common effect model | 10.8 [10.0-11.7] | – | 100.0% |
| Random effects model | 11.6 [8.8-15.2] | 100.0% | – |
| $I^2$=69%, $\tau^2$=0.4885, $\chi^2_{32}$=103.94 ($p$<0.001) | | | |
| Test for subgroup differences (fixed effect): $\chi^2_1$=11.24, df=1 ($p$<0.001) | | | |
| Test for subgroup differences (random effects): $\chi^2_1$=2.36, df=1 ($p$=0.12) | | | |



# ESC 2025 Guidelines





# ESC 2025 Guidelines

| Patients with severe tricuspid regurgitation without left-sided valvular heart disease requiring surgery | | |
|---|---|---|
| TV surgery[c] is recommended in symptomatic patients with severe primary TR without severe RV dysfunction or severe PH. | I | C |
| TV surgery[c] should be considered in asymptomatic patients with severe primary TR who have RV dilatation/RV function deterioration, but without severe LV/RV dysfunction or severe PH. | IIa | C |
| TV surgery[c] should be considered in patients with severe secondary TR who are symptomatic or have RV dilatation/RV function deterioration, but without severe LV/RV dysfunction or PH.[685,720,745–747] | IIa | B |
| Transcatheter TV treatment should be considered to improve quality of life and RV remodelling in high-risk patients with symptomatic severe TR despite optimal medical therapy in the absence of severe RV dysfunction or pre-capillary PH.[713,733,735,738,748–751] | IIa | A |



LV, left ventricle/left ventricular; PH, pulmonary hypertension; RV, right ventricle/right ventricular; TR, tricuspid regurgitation; TV, tricuspid valve.

[a]Class of recommendation.

[b]Level of evidence.

[c]Valve repair whenever possible.

# Determinants of clinical outcomes of surgery for isolated severe tricuspid regurgitation

Sung Jun Park ,[1] Jin Kyung Oh ,[2] Seon-Ok Kim,[3] Seung-Ah Lee,[4] Ho Jin Kim,[1] Sahmin Lee,[4] Sung Ho Jung,[1] Jong-Min Song,[4] Suk Jung Choo,[1] Duk-Hyun Kang,[4] Cheol Hyun Chung,[1] Jae-Kwan Song ,[4] Jae Won Lee ,[1] Dae-Hee Kim ,[4] Joon Bum Kim[1]

**Table 3** Univariable and multivariable analyses for the primary outcome

| | Univariable | | | Multivariable | | |
|---|---|---|---|---|---|---|
| | HR | 95% CI | P value | HR | 95% CI | P value |
| Age | 1.05 | 1.03 to 1.08 | <0.001 | 1.05 | 1.02 to 1.08 | 0.001 |
| NYHA class 3–4 | 1.79 | 1.06 to 3.04 | 0.031 | | | |
| Coronary artery disease | 2.16 | 1.08 to 4.33 | 0.029 | | | |
| Haemoglobin | 0.75 | 0.67 to 0.84 | <0.001 | 0.83 | 0.73 to 0.94 | 0.003 |
| Platelet count | 0.99 | 0.986 to 0.996 | <0.001 | | | |
| Estimated glomerular filtration rate | 0.98 | 0.97 to 0.99 | 0.002 | | | |
| Total bilirubin | 1.58 | 1.02 to 2.33 | 0.022 | 1.50 | 1.02-2.20 | 0.040 |
| Albumin | 0.49 | 0.32 to 0.76 | 0.001 | | | |
| Tricuspid regurgitant jet area | 1.05 | 1.03 to 1.08 | <0.001 | 1.03 | 1.01 to 1.06 | 0.005 |
| Tricuspid annular diameter | 1.06 | 1.01 to 1.10 | 0.014 | | | |
| Right atrial pressure | 1.23 | 1.09 to 1.39 | <0.001 | 1.14 | 1.02 to 1.28 | 0.022 |
| Fractional area change | 0.95 | 0.92 to 0.99 | 0.015 | | | |

NYHA. New York Heart Association.

Park SJ, *et al*. *Heart* 2021;**107**:403–410. doi:10.1136/heartjnl-2020-317715

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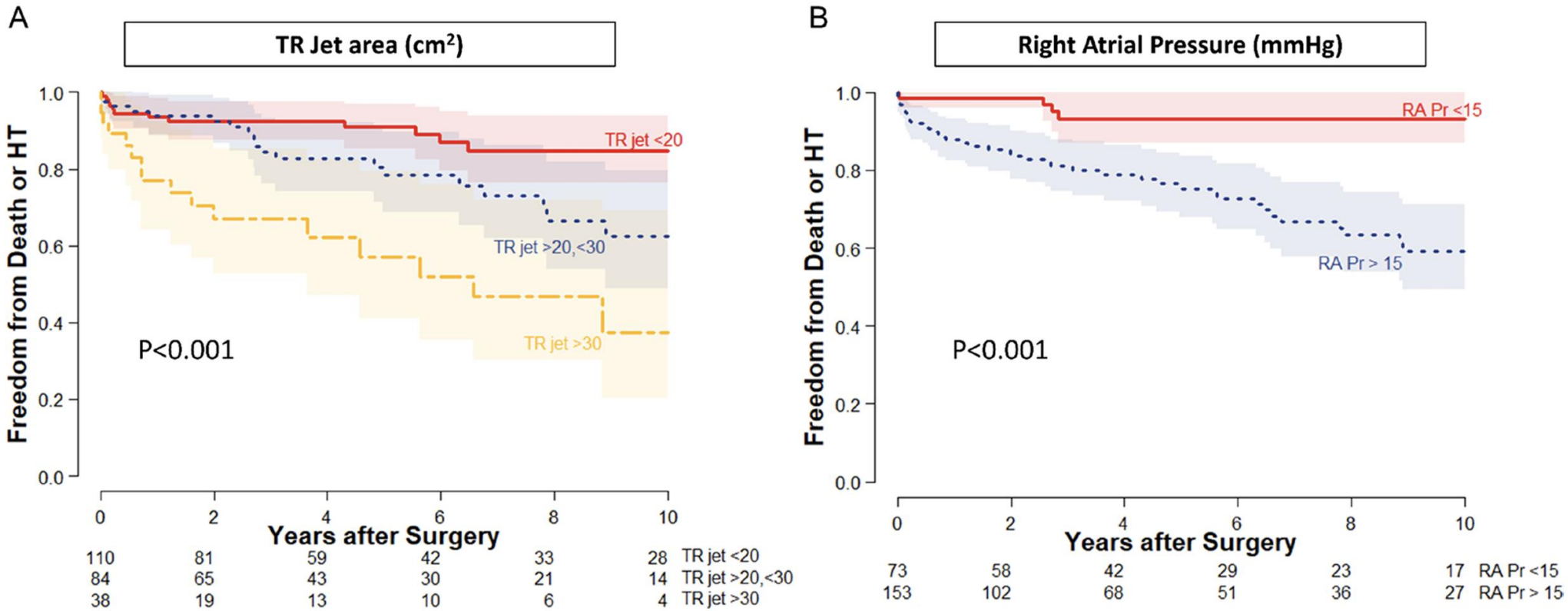


**Figure 2** The primary outcomes stratified by (A) tricuspid regurgitant (TR) jet area and (B) right atrial (RA) pressure.

Park SJ, *et al*. *Heart* 2021;**107**:403–410. doi:10.1136/heartjnl-2020-317715

# Determinants of clinical outcomes of surgery for isolated severe tricuspid regurgitation

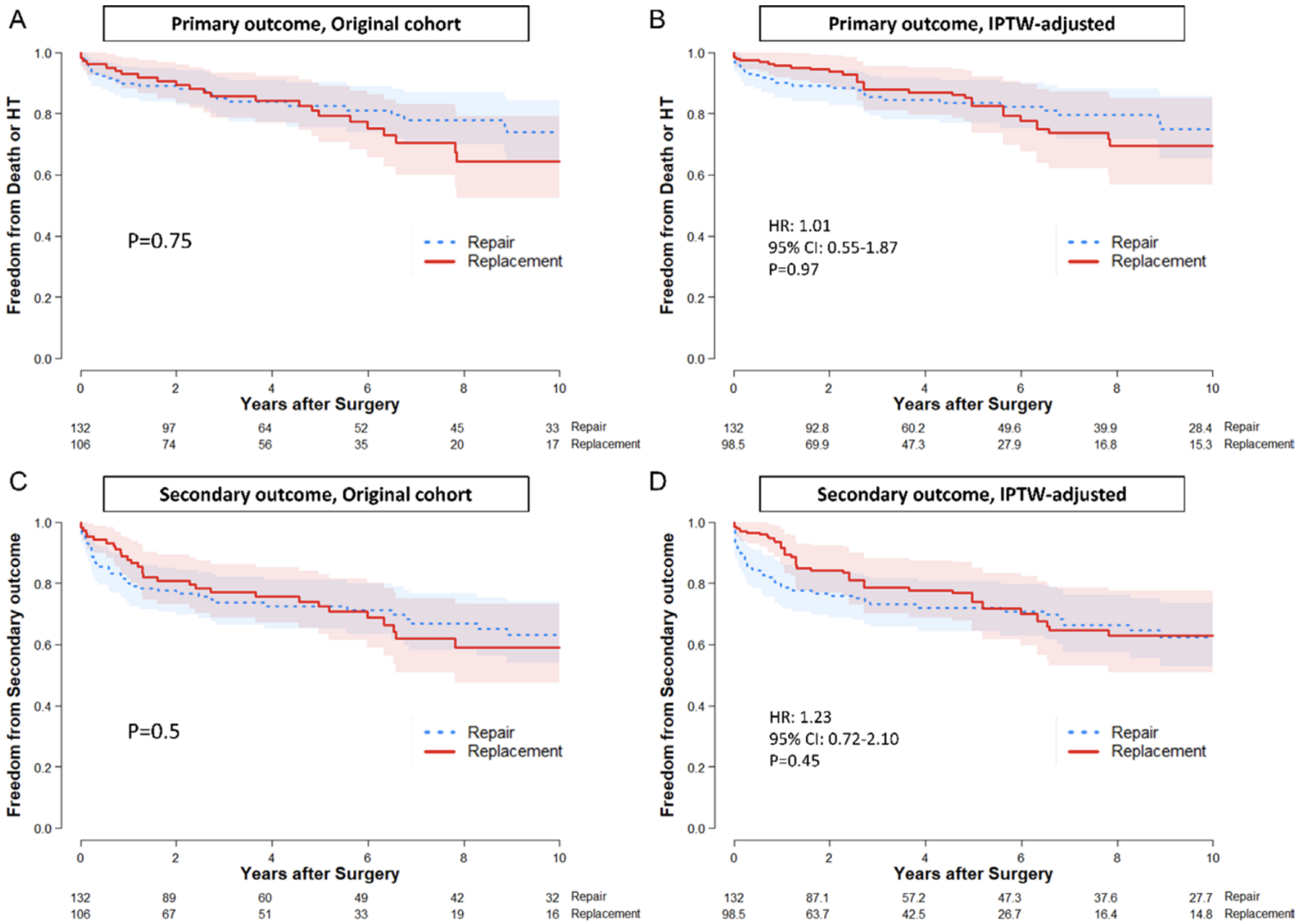


**Figure 3** Repair versus replacement. (A) The primary outcome in the original cohort and (B) the IPTW-adjusted cohort. (C) The secondary outcome in the original cohort and (D) the IPTW-adjusted cohort. IPTW, inverse probability of treatment weighting.

- Risk stratification model

## TRI-SCORE: a new risk score for in-hospital mortality prediction after isolated tricuspid valve surgery

- Consecutive adult patients who underwent ITVS for severe non-congenital TR at 12 French centres between 2007 and 2017
- 466 patients (60 ± 16 years, 49% female, functional TR in 49%).
- Inhospital mortality rate was 10%.
- Scoring system to predict in-hospital mortality using multivariable logistic regression and bootstrapping

European Heart Journal (2022) 43, 654–662
https://doi.org/10.1093/eurheartj/ehab679

# Isolated tricuspid reg: timing for intervention ?

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## TRI-SCORE: a new risk score for in-hospital mortality prediction after isolated tricuspid valve surgery

**Risk factors and scoring system for in-hospital mortality after isolated tricuspid valve surgery**

| Risk factors (final model from multivariate analysis) | Scoring |
|---|---|
| Age ≥ 70 years | 1 |
| NYHA functional class III-IV | 1 |
| Right-sided heart failure signs | 2 |
| Daily dose of furosemide ≥ 125mg | 2 |
| Glomerular filtration rate < 30 ml/min | 2 |
| Elevated total bilirubin | 2 |
| Left ventricular ejection fraction < 60% | 1 |
| Moderate/severe right ventricular dysfunction | 1 |
| Total | 12 |

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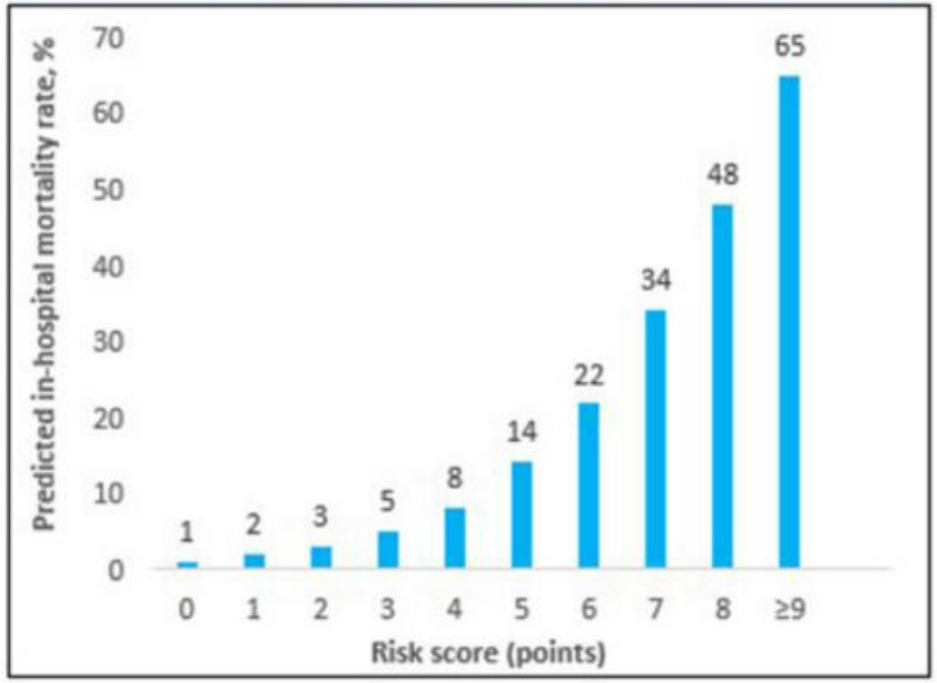
**Predicted in-hospital mortality rate according to the final risk score model**

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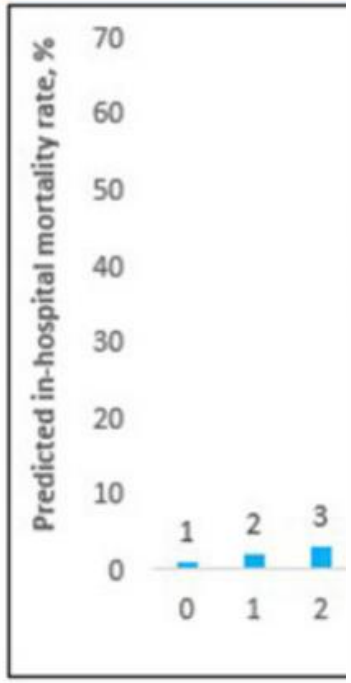
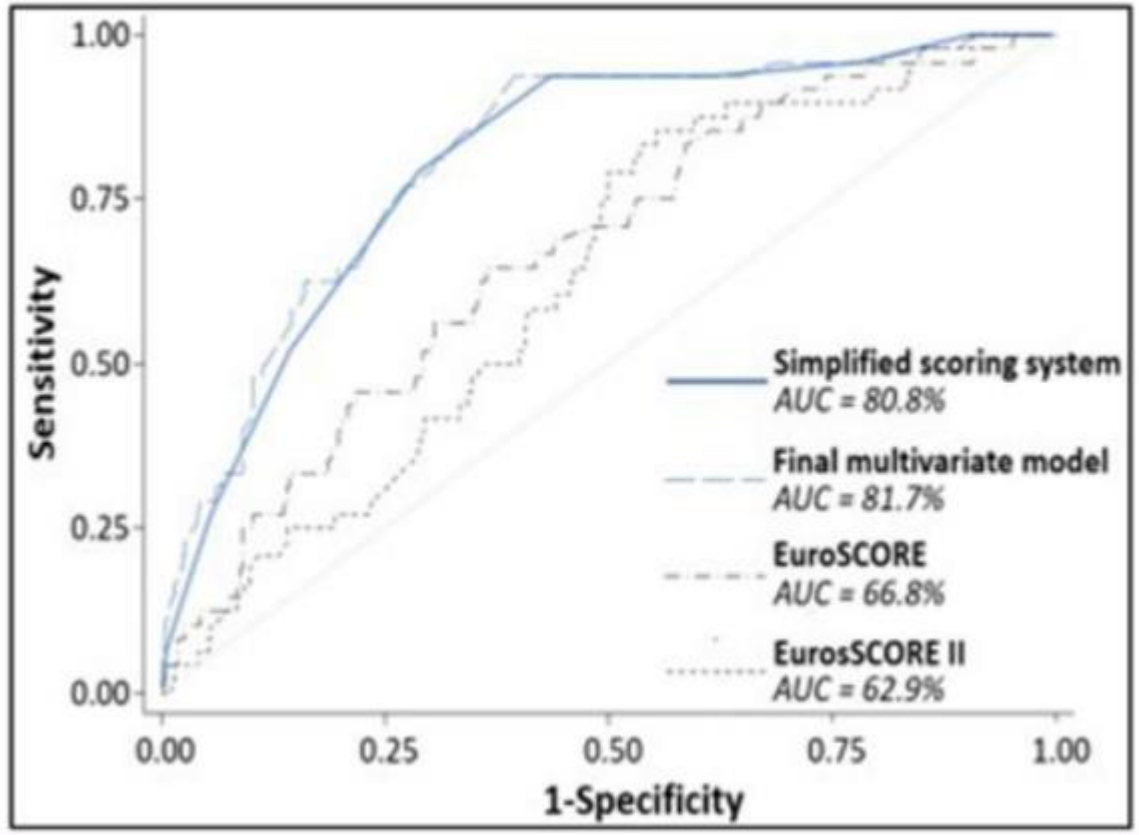
according




**Receiver operating characteristic curves**

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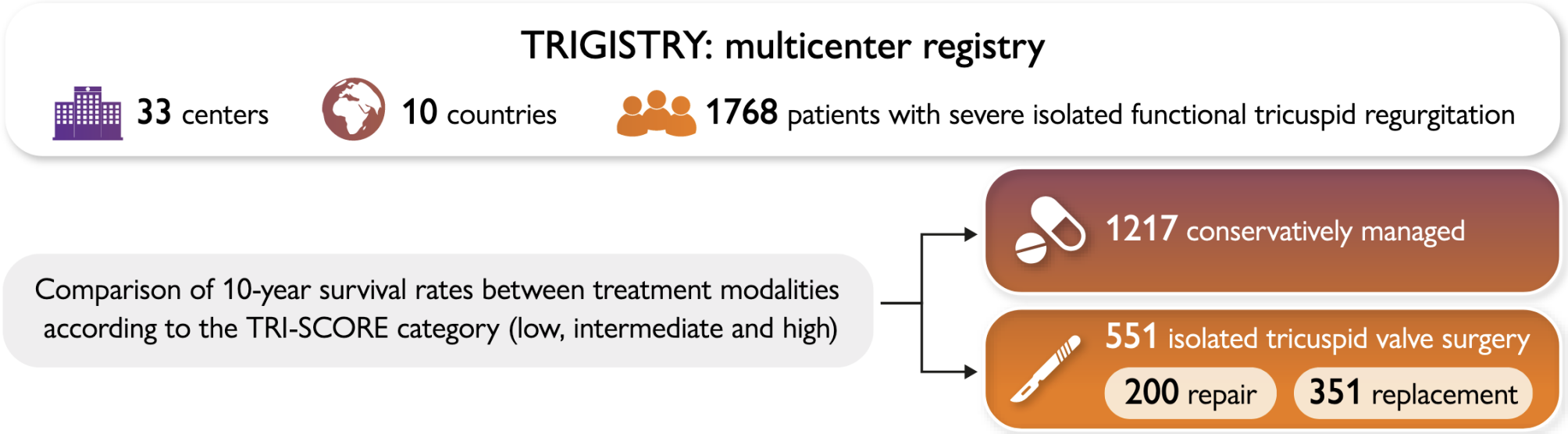
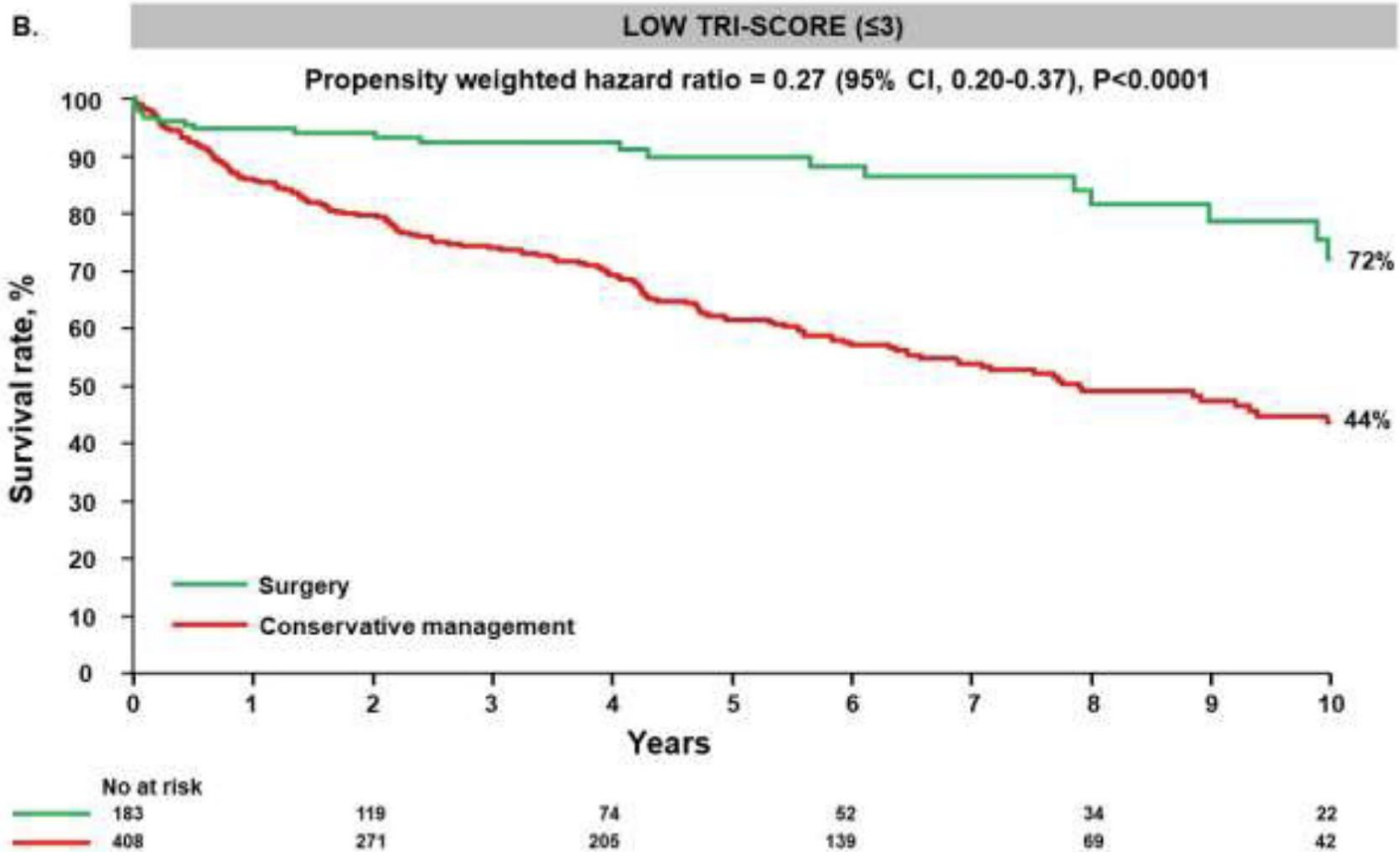
ESC European Society of Cardiology
European Heart Journal (2024) **45**, 4512–4522
https://doi.org/10.1093/eurheartj/ehae578



# Benefit of isolated surgical valve repair or replacement for functional tricuspid regurgitation and long-term outcomes stratified by the TRI-SCORE

**Julien Dreyfus [1]*, Fernando Juarez-Casso[2], Alessandra Sala[3],**






Eur Heart J. 2024 Feb 21;45(8):586-597.

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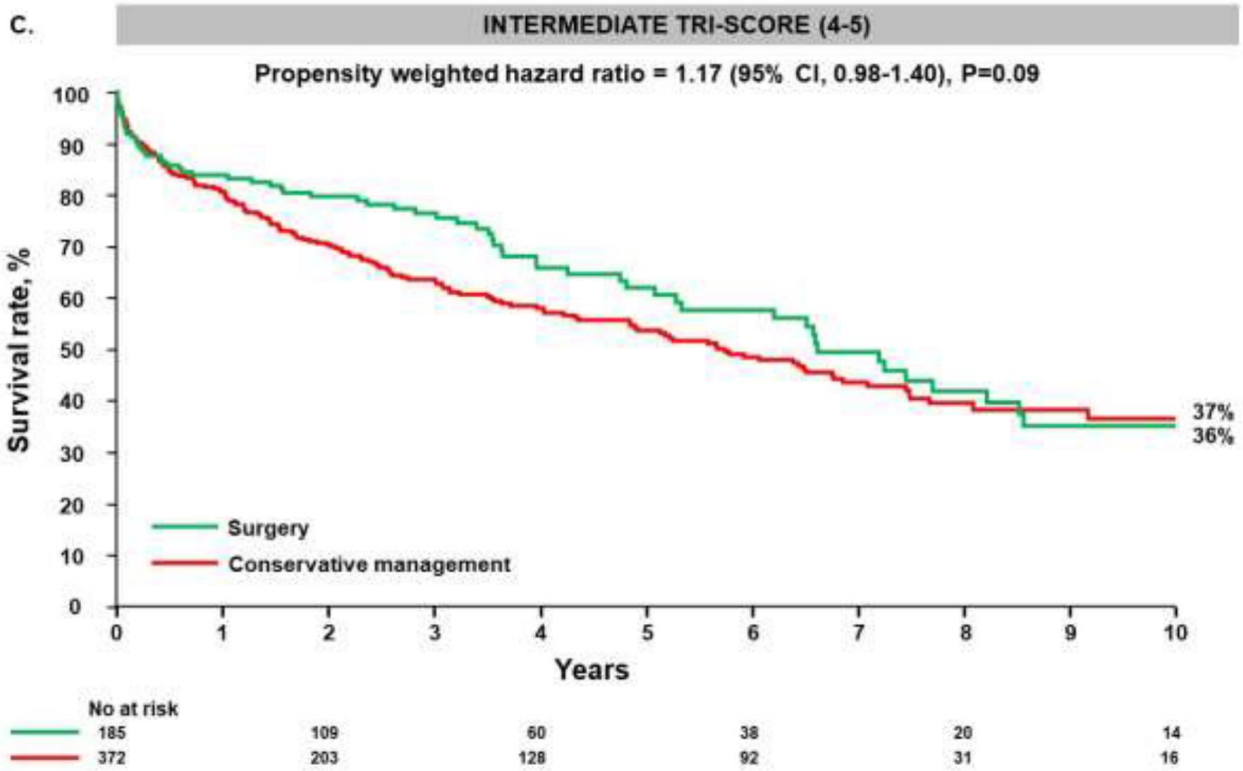


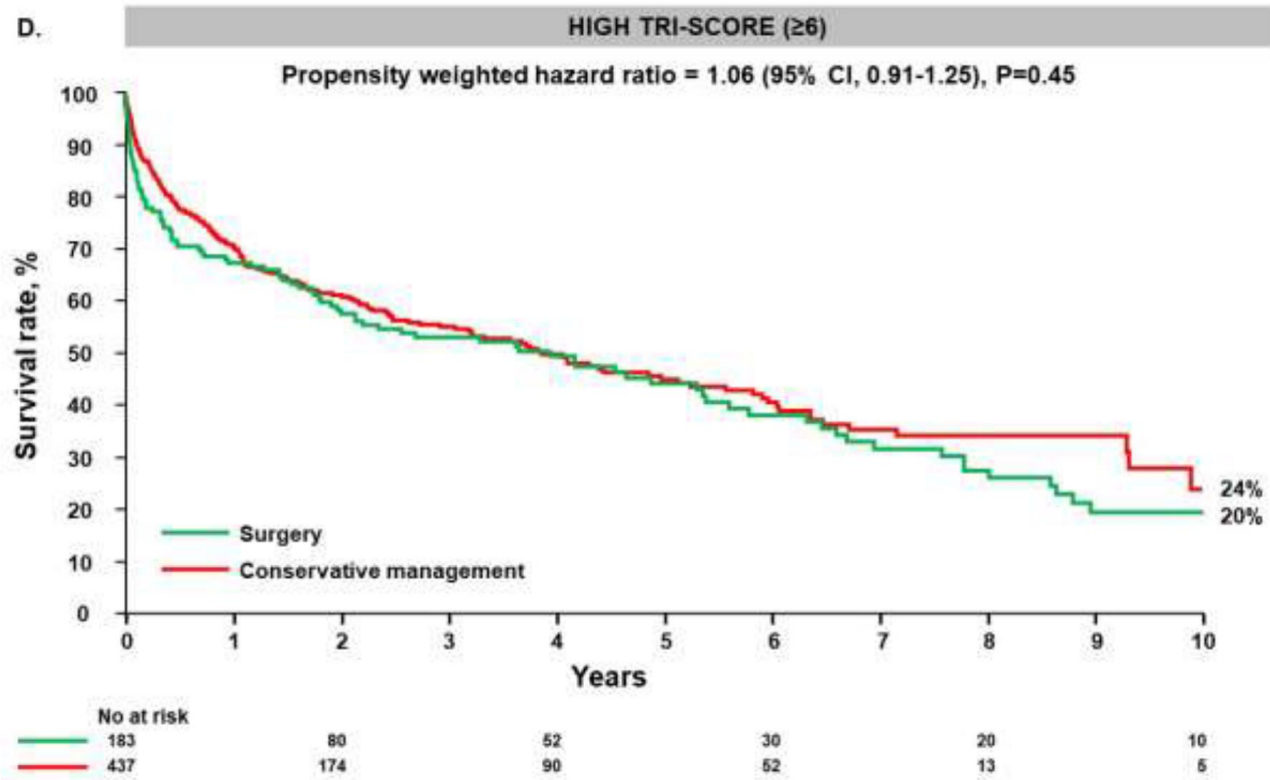


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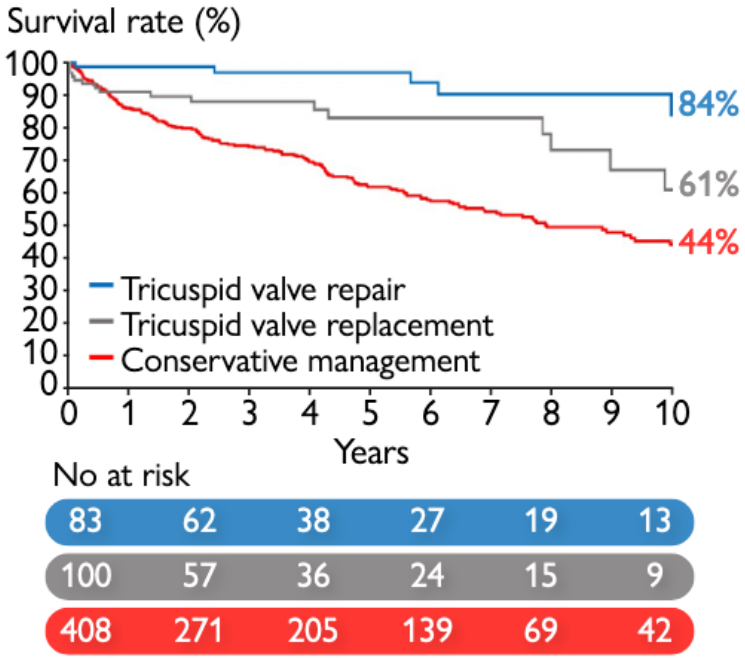
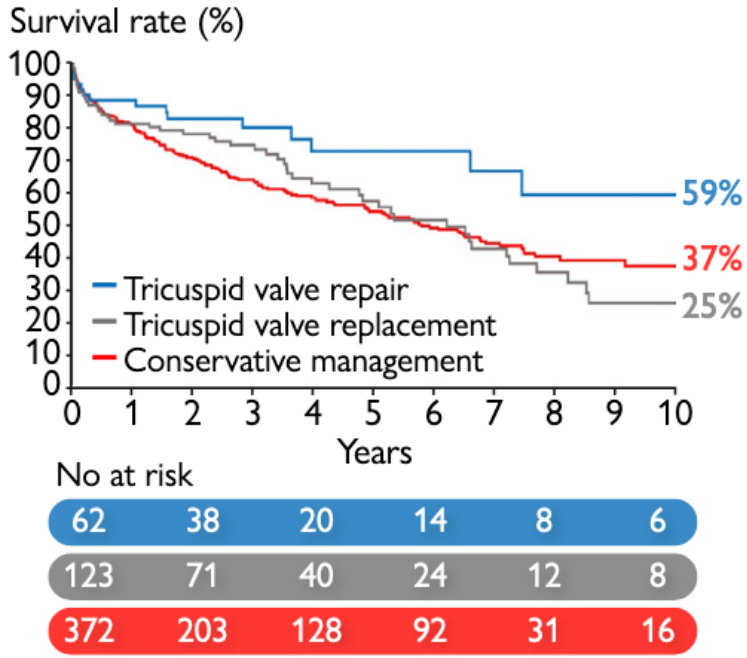
## Low TRI-SCORE (≤ 3)




No at risk

| | | | | | |
|---|---|---|---|---|---|
| 83 | 62 | 38 | 27 | 19 | 13 |
| 100 | 57 | 36 | 24 | 15 | 9 |
| 408 | 271 | 205 | 139 | 69 | 42 |

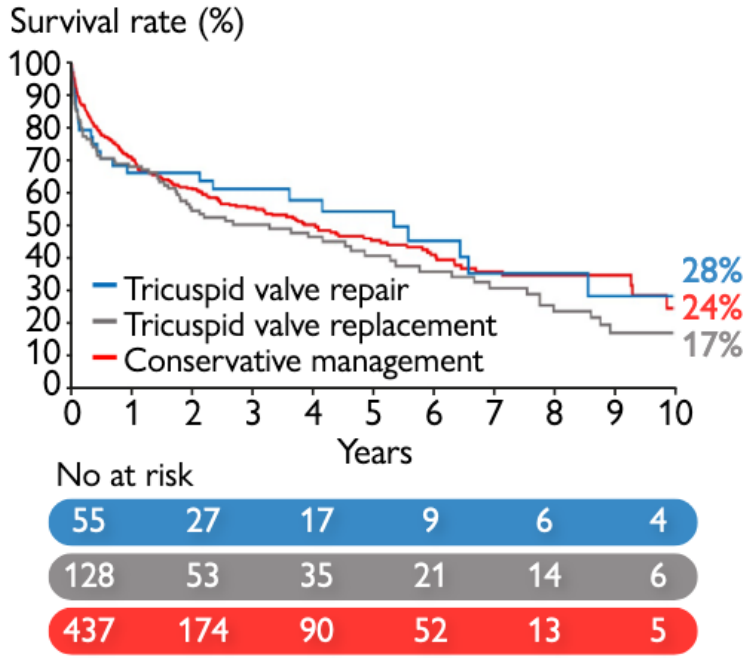
## Intermediate TRI-SCORE (4–5)




No at risk

| | | | | | |
|---|---|---|---|---|---|
| 62 | 38 | 20 | 14 | 8 | 6 |
| 123 | 71 | 40 | 24 | 12 | 8 |
| 372 | 203 | 128 | 92 | 31 | 16 |

## High TRI-SCORE (≥ 6)




No at risk

| | | | | | |
|---|---|---|---|---|---|
| 55 | 27 | 17 | 9 | 6 | 4 |
| 128 | 53 | 35 | 21 | 14 | 6 |
| 437 | 174 | 90 | 52 | 13 | 5 |

## Propensity weighted hazard ratio

| | Low TRI-SCORE (≤ 3) | Intermediate TRI-SCORE (4–5) | High TRI-SCORE (≥ 6) |
|---|---|---|---|
| Repair vs conservative management | 0.11 (95% CI, 0.06–0.19), P < 0.0001 | 0.49 (95% CI, 0.35–0.68), P < 0.0001 | 0.86 (95% CI, 0.68–1.08), P = 0.20 |
| Replacement vs conservative management | 0.65 (95% CI, 0.47–0.90), P = 0.009 | 1.43 (95% CI, 1.18–1.72), P = 0.0002 | 1.58 (95% CI, 1.35–1.86), P < 0.0001 |
| Repair vs replacement | 0.17 (95% CI, 0.09–0.32), P < 0.0001 | 0.34 (95% CI, 0.24–0.48), P < 0.0001 | 0.54 (95% CI, 0.43–0.68), P < 0.0001 |

# Outcomes of Isolated Tricuspid Valve Surgery: A Society of Thoracic Surgeons Analysis and Risk Model

Vinod H. Thourani, MD,[1] Levi Bonnell, PhD,[2] Moritz C. Wyler von Ballmoos, MD, PhD,[3] J. Hunter Mehaffey, MD,[4] Michael Bowdish, MD,[5] Paul Kurlansky, MD,[6] Jeffrey P. Jacobs, MD,[7] Sean O'Brien, PhD,[8] David M. Shahian, MD,[9] and Vinay Badhwar, MD[4]





**TABLE 2 Observed Outcomes by Procedure Type in Isolated Tricuspid Valve Surgery Study Group**

| | N (%) | | |
|---|---|---|---|
| Outcome | TVRr N = 13,587 | TVr n = 5583 | TVR n = 8004 |
| Operative mortality | 760 (5.6) | 304 (5.4) | 456 (5.7) |
| Stroke | 197 (1.4) | 116 (2.1) | 81 (1.0) |
| Renal failure | 928 (6.8) | 400 (7.2) | 528 (6.6) |
| Prolonged ventilation | 2884 (21.2) | 1299 (23.3) | 1585 (19.8) |
| Reoperation | 1083 (8.0) | 484 (8.7) | 599 (7.5) |
| Morbidity and mortality | 3717 (27.4) | 1576 (28.2) | 2141 (26.7) |
| DSWI[a] | 79 (0.6) | 30 (0.5) | 49 (0.6) |
| Prolonged LOS >14 d | 4908 (36.1) | 1978 (35.4) | 2930 (36.6) |
| Short LOS <6 d | 2368 (17.4) | 1223 (21.9) | 1145 (14.3) |

[a]Risk models not created because of low event counts. DSWI, deep sternal wound infection; LOS, length of stay; TVr, tricuspid valve repair; TVR, tricuspid valve replacement; TVRr, tricuspid valve replacement or repair.

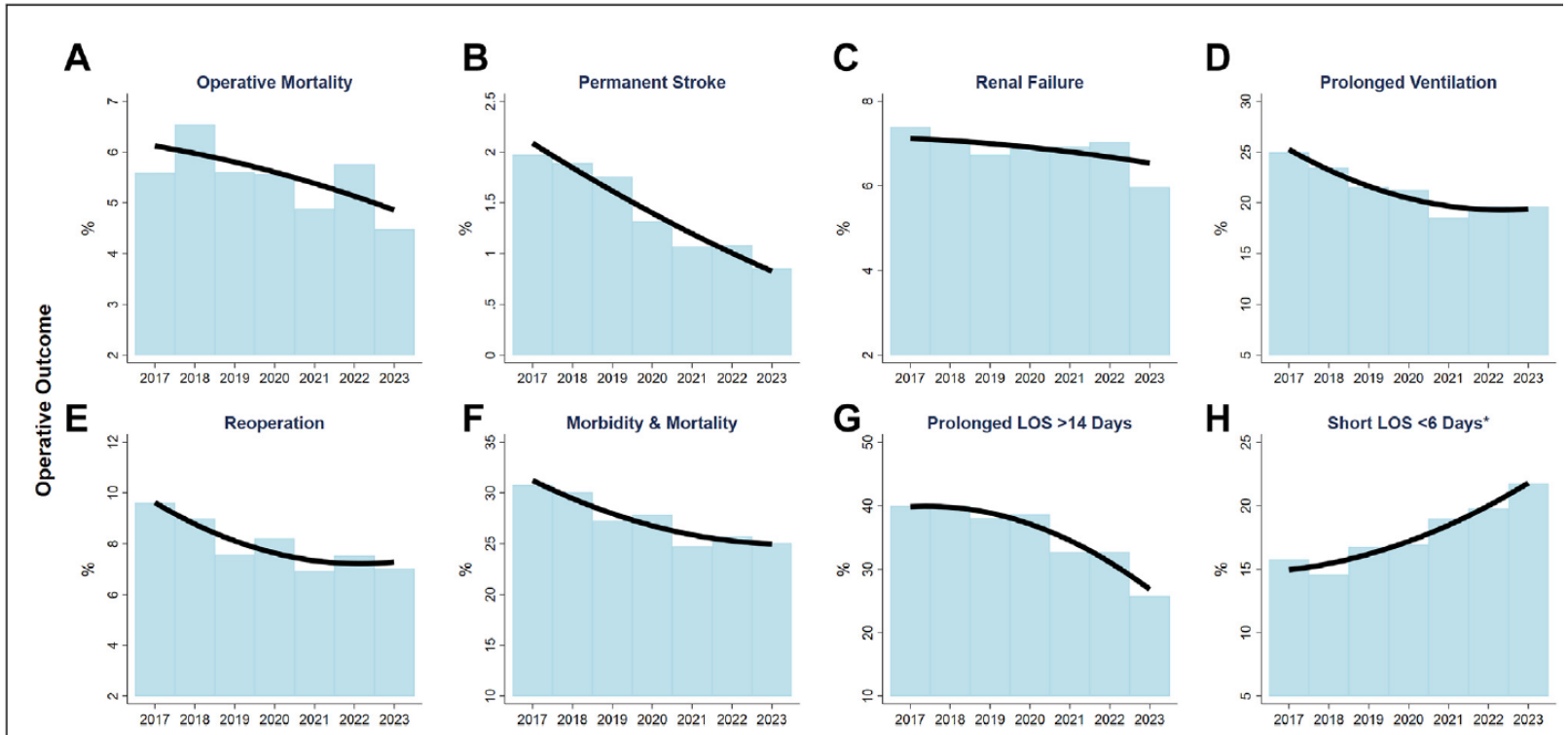
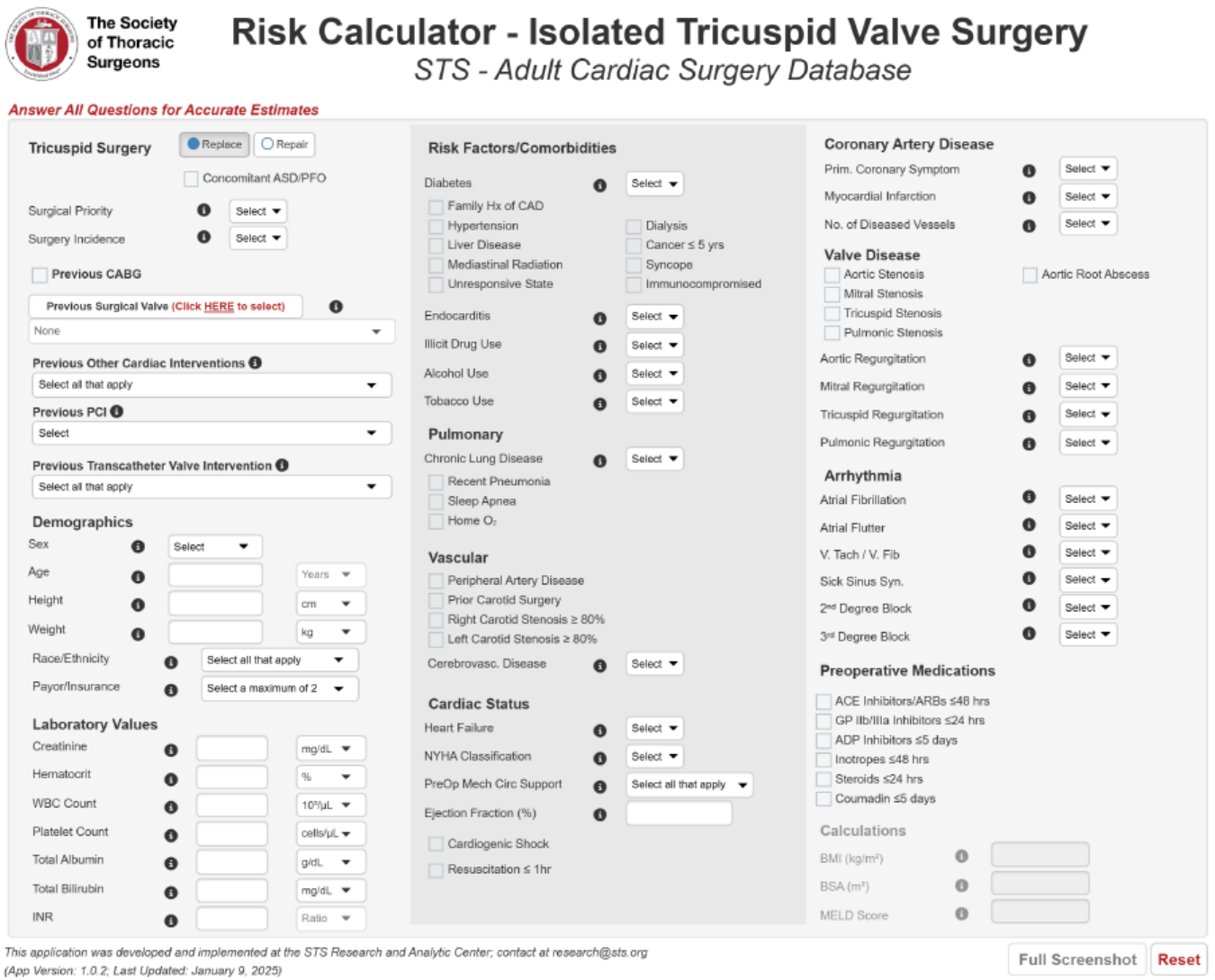
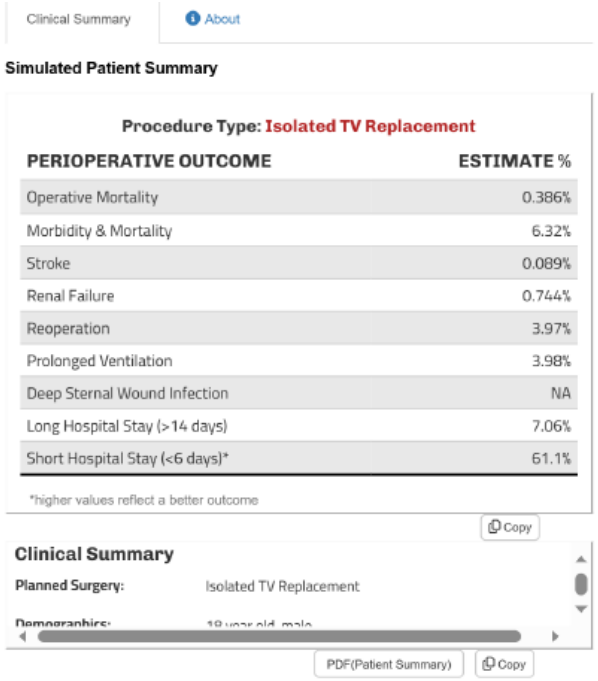



**FIGURE 2** Observed outcome over the study period for each of the 8 outcomes: (A) operative mortality, (B) permanent stroke, (C) renal failure, (D) prolonged ventilation, (E) reoperation, (F) morbidity and mortality, (G) prolonged length of stay (LOS) >14 days, and (H) short LOS <6 days.

*Ann Thorac Surg* 2024;**118**:873-881. doi: https://doi.org/10.1016/j.athoracsur.2024.04.014

- STS tricuspid score

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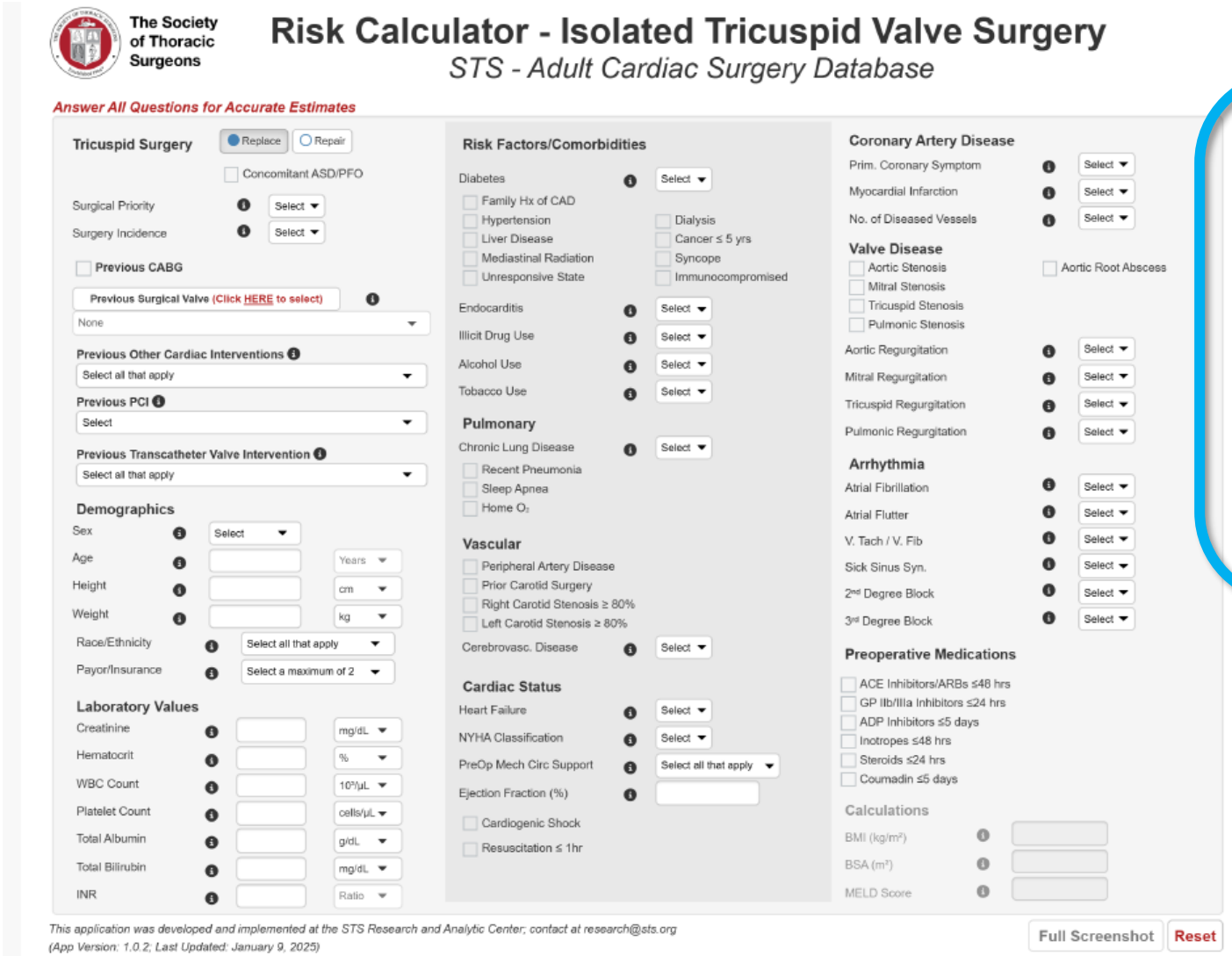


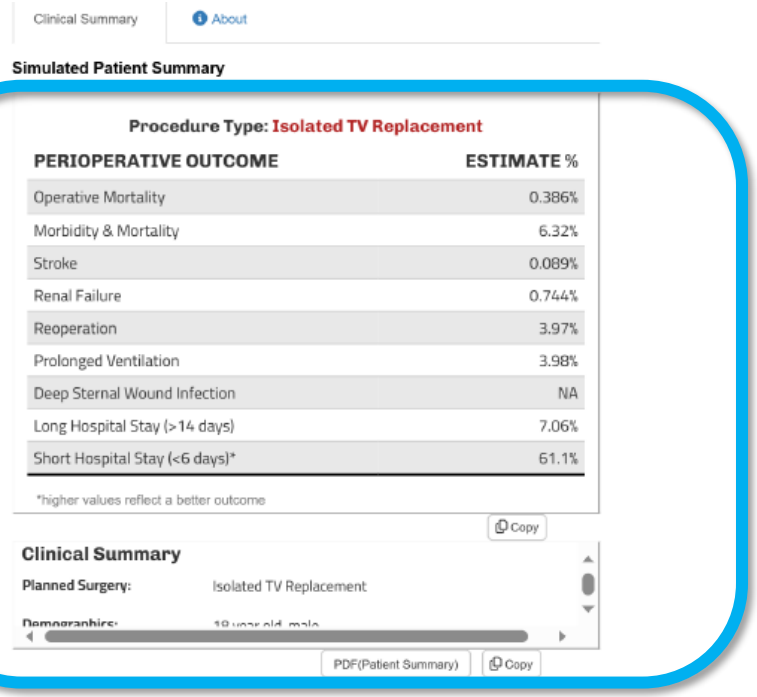


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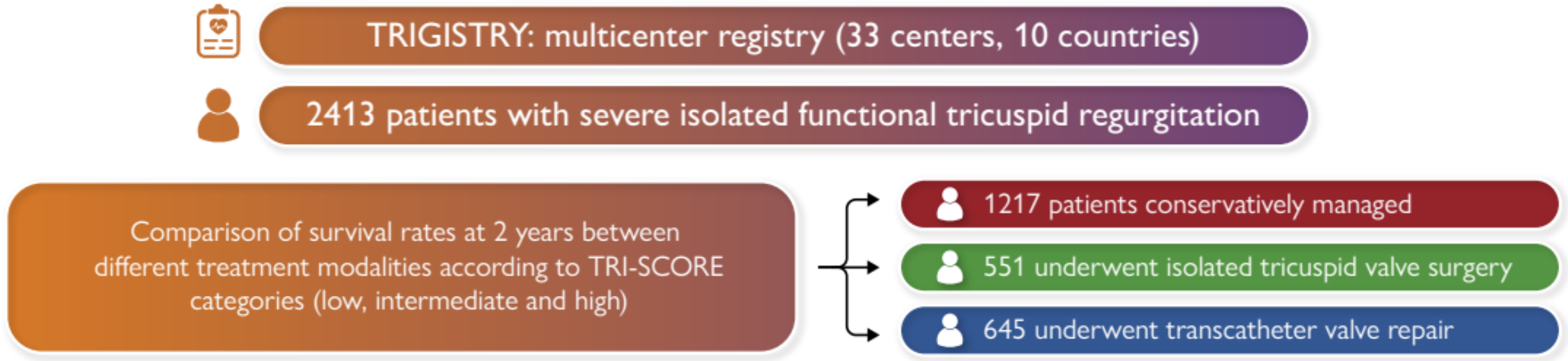
# Conclusion

- More attention needed to diagnosing moderate and severe TR, with use of quantitative Doppler echocardiographic methods.
- Early consideration of tricuspid surgery before the occurrence of severe HF.
- Mandatory multidisciplinary Heart Team discussion.
- Risk analysis to optimize patients and procedure selection
- Need to test efficacy of therapies in appropriately designed randomized clinical trials.
  - Transchateter vs Medical Therapy
  - Minimally invasive surgery vs Transchateter therapy
  - Repair vs Replacement

Thank you

# Isolated tricuspid reg: timing for intervention ?

## TRI-SCORE and benefit of intervention in patients with severe tricuspid regurgitation




European Heart Journal (2024) 45, 586–597 https://doi.org/10.1093/eurheartj/ehad585

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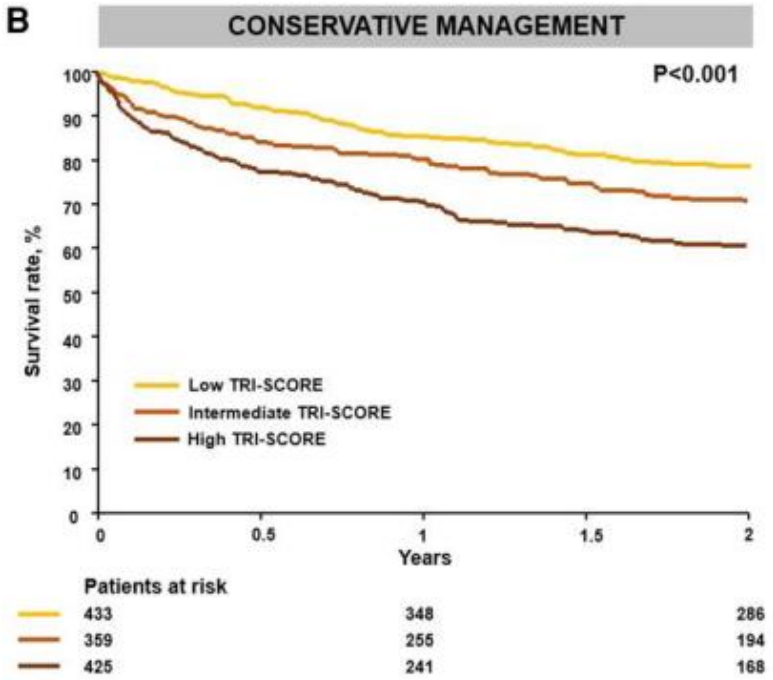


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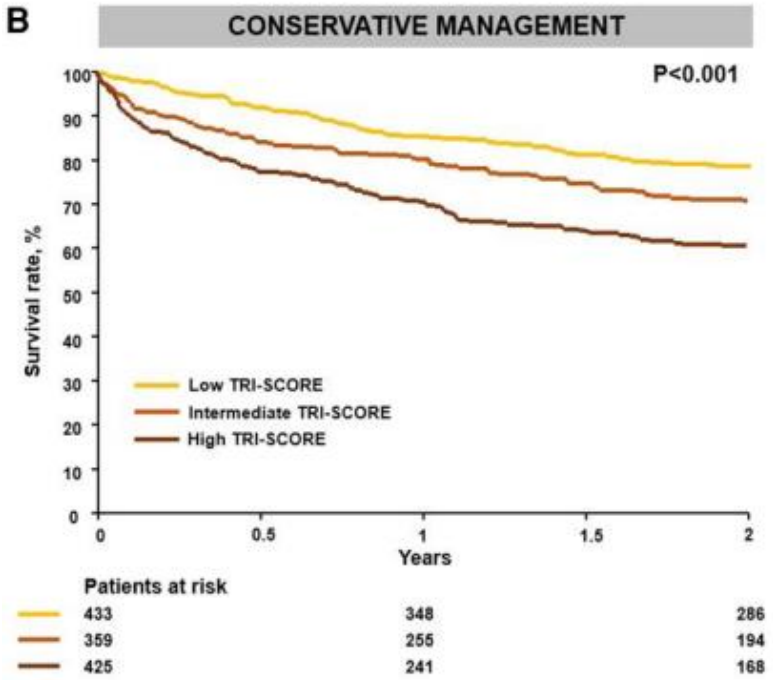


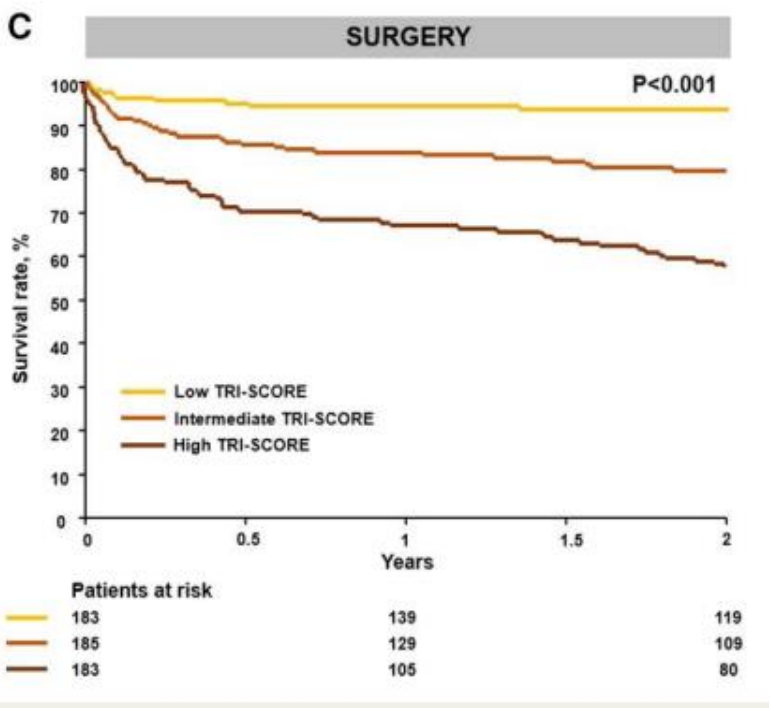


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# Isolated tricuspid reg: timing for intervention ?

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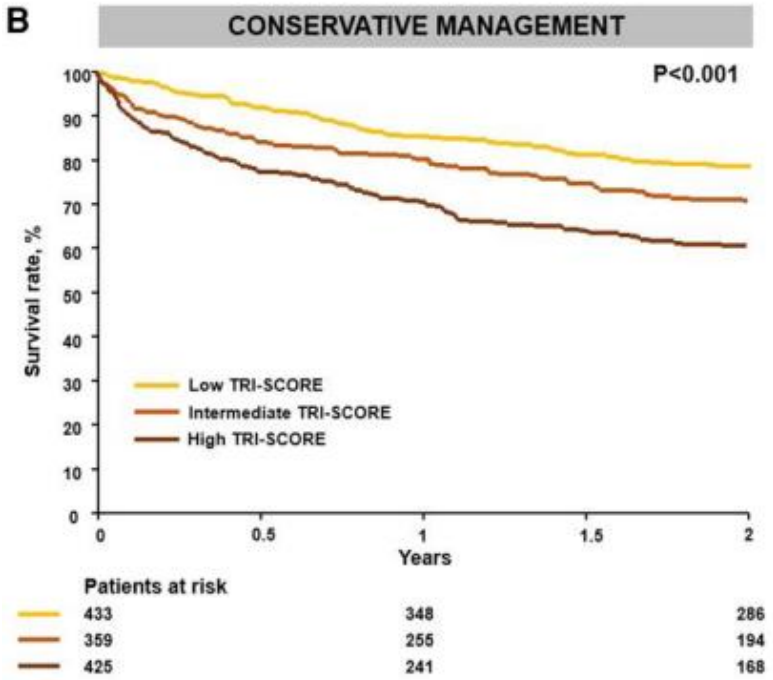


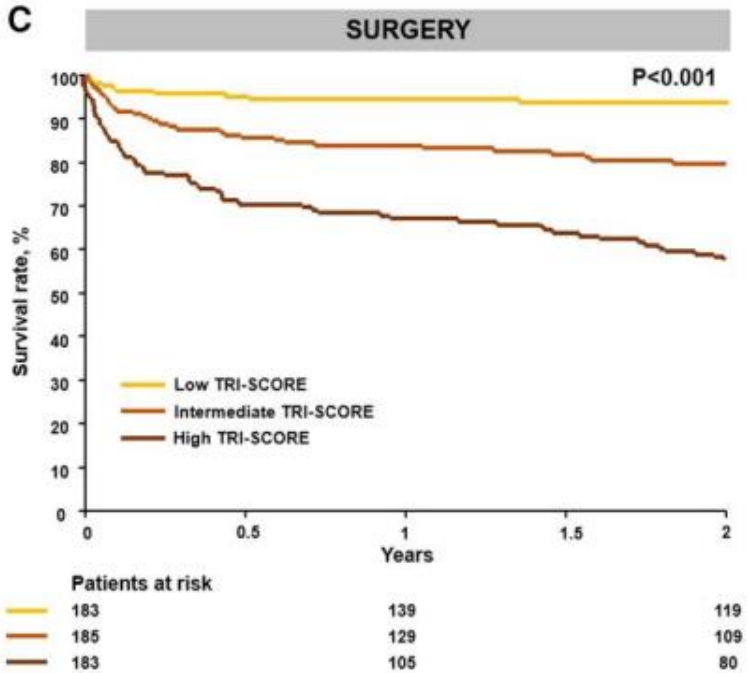


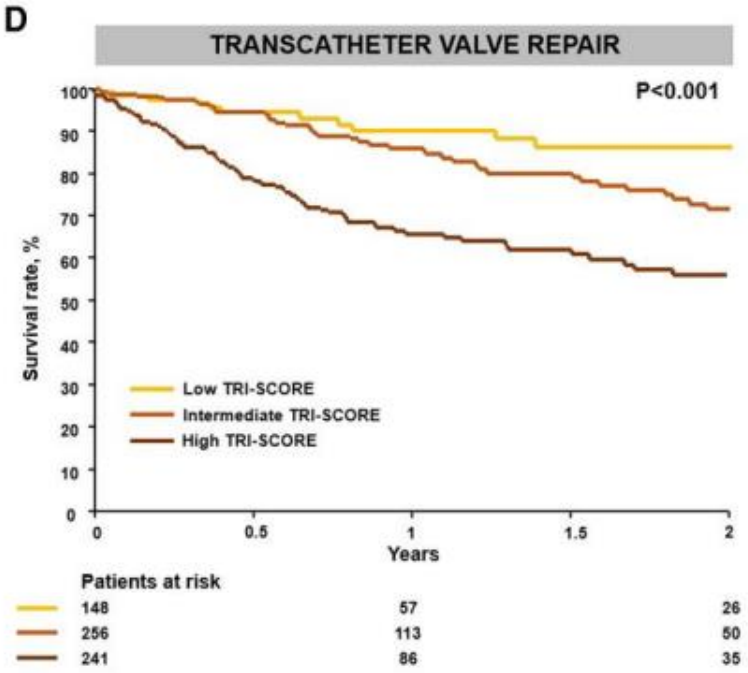


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